(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 292 072 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **10.02.93** (51) Int. Cl.[5]: **H04L 12/44**

(21) Application number: **88200992.1**

(22) Date of filing: **18.05.88**

(54) **Communication device and star circuit for use in such a communication device, and device comprising such a circuit.**

(30) Priority: **22.05.87 NL 8701221**

(43) Date of publication of application:
23.11.88 Bulletin 88/47

(45) Publication of the grant of the patent:
10.02.93 Bulletin 93/06

(84) Designated Contracting States:
DE FR GB IT NL SE

(56) References cited:
EP-A- 0 073 352
FR-A- 2 570 563

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Description

BACKGROUND OF THE INVENTION

The invention relates to a communication device, comprising a star circuit whereto a variable number of electrical bus connections with stations coupled thereto can be connected in order to form, by way of the assembly of bus connections, a bus organization for digital communication signals between the assembly of stations.

Generally, electrical bus connections should be electrically terminated at both ends by means of a characteristic impedance. When a number of stations are connected to an electrical bus connection and each of these stations possesses two connections for the electrical bus connection, these stations can be included in the communication device by the so-called looping through of the connections in the stations. In that case, the stations at the ends of the electrical bus connection in principle have a free connection where the electrical bus connection should be terminated. When a number of stations with a star circuit are connected to electrical bus connections, looping through does not take place and each station should be electrically terminated at the free connection, that is to say by means of a characteristic impedance which is dependent of the entire communication device with the connected stations. In order to avoid this system-dependent termination, each bus connection should be electrically terminated at the input of the station connected thereto. The communication device with the star circuit then comprises as many parallel terminating impedances as there are stations connected to the communication device. The impedance configuration is then again dependent on the number of stations, so that the operation of the communication device may be affected.

SUMMARY OF THE INVENTION

Therefore, it is the object of the invention to provide a communication device of the kind set forth in which said termination problems are mitigated. To achieve this, the communication device in accordance with the invention is characterized in that for each electrical bus connection to be connected the star circuit comprises an own connection network with a buffer element and a logic circuit, a communication signal which originates from a first station and which is supplied via a relevant bus connection, being stored in the associated buffer element, a buffer output signal derived from said communication signal being applied to the logic circuit of all connection networks of the star circuit, the output signal of each of these logic circuits, with the exception of that of the connection network having received the communication signal originating from the first station, being applied, via a relevant bus connection, to a station connected thereto, each buffer element comprising a gate circuit whereto the signal output via the output of the relevant logic circuit is applied in order to ensure that this signal, to be applied to a relevant station, is not written into the buffer element, each of the electrical bus connections between a relevant station and the star circuit being electrically terminated at both ends. By itself, an electrical/logical star circuit has been described in EP-A-0 073.352. The reference does not provide for the case of frequent change of the configuration of stations.

In order to reduce the number of wires in the electrical bus connections, a preferred embodiment of the communication device in accordance with the invention is also characterized in that the electrical bus connection via which a communication signal is transported from a station to the star circuit and that via which a communication signal is transported from the star circuit to the relevant station is the same, the output of each logic circuit being coupled to said electrical bus connection in a wired-logic configuration at the input of the relevant connection network, so that the bus connection carries a communication signal only if either a relevant station outputs a communication signal while no signal is output via the output of the relevant logic circuit, or if a signal is output via the output of the relevant logic circuit while no communication signal is output by the relevant station.

Even though the electrical bus connections via which signals are applied to the star circuit may differ from the electrical bus connections via which signals are applied from the star circuit to the stations, the use of the same electrical bus connections is to be preferred. These electrical bus connections may be formed by coaxial cables or, for example by twisted wire pairs; in the latter case, the difference signal of the two wires is applied to the relevant connection network and the signal supplied by this connection network is split into signal values which are suitable for the twisted wire pairs. The coupling of the output of a logic circuit to the relevant bus connection at the input of the connection network which is connected to this bus connection and which comprises said logic circuit, can be realized by way of a "wired-AND" connection as well as by way of a "wired-NOR" connection; the choice in this respect will be governed by the voltage level of the relevant signals and.by the construction of the logic circuits in the connection networks. The invention also relates to a star circuit for use in such a communication device; it may be constructed, for example as a printed wiring board on which a number of TTL logic integrated circuits

are mounted. The invention also relates to a device comprising a built-in star circuit and at least one station which is internally connected thereto via an associated bus connection, for example a television, and also relates to a device wherein said star circuit comprises at least one externally accessible connection for connection of an associated external station, for example a video recorder, via an external bus connection.

BRIEF DESCRIPTION OF THE FIGURES

The invention will be described in detail hereinafter with reference to the accompanying diagrammatic drawings; therein:

Figure 1 shows a communication device with electrical bus connections in accordance with the invention, three stations being connected to said communication device;

Figure 2 shows an embodiment of a connection network for a star circuit;

Figure 3 shows an embodiment of the star circuit for a communication device whereto three stations can be connected; and

Figures 4A and 4B show two series of time diagrams illustrating the operation of the embodiment shown in Figure 3.

The embodiments to be described with reference to the Figures are by no means intended to restrict the scope of the invention; they merely serve to illustrate the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 shows a communication device comprising electrical bus connections in a star configuration whereto three stations 1, 2 and 3 are connected. The communication device comprises electrical bus connections 4, 5 and 6 and a star circuit 7. The electrical bus connections 4, 5 and 6 are electrically terminated at the input of the star circuit 7 by means of a characteristic impedance 8, 9, 10, respectively. The star circuit may in principle be constructed for an arbitrary number of stations. A connection network is then provided for each station. Such a star circuit may be constructed as a printed wiring board on which there are mounted a number of integrated circuits, for example appropriate standard types (TTL and the like).
Alternatively, each connection network is formed by a single integrated circuit in MSI technology. The entire star circuit can also be formed by a single integrated circuit. Generally, the termination resistors 8, 9 ... will form a fixed part of the star circuit. This offers the advantage that disconnection/connection of a station can be realized by means of a connector and the like, without further facilities being required. Should any connection network not be connected to a station, the system will operate in the same manner. Usually star circuits comprising a fixed number of station connections will be manufactured, for example six connections. If a larger number of stations is connected, a second star circuit may be connected to one of the station connections. It has been found that the system then continues to operate in the same manner, be it probably with a slightly lower operating frequency. A communication device of the present kind can be used, for example for exchanging control signals between consumer products such as TV receivers, CD players, tape recorders, microwave ovens, clocks, and installations for heating/light/air treatment.

In Figure 1 the electrical bus connections are physically separated from one another, which means that an electric current in a given bus connection in no way represents a load for a current source which is directly connected to any other bus connection, so that dynamic phenomena on the relevant bus connections which do not manifest themselves as a change of the logic state do not have an effect either on the behaviour of another bus connection. The electrical bus connections, however, are functionally coupled by the star circuit 7, which means that, subject to conditions to be described hereinafter, the voltage levels are taken over by the star circuit 7 from the electrical bus connections or vice versa by the electrical bus connections from the star circuit.

DESCRIPTION OF A CONNECTION NETWORK

For each connected electrical bus connection the star circuit 7 comprises a connection network 11, 12, 13, respectively. Figure 2 shows a construction of such a connection network, that is to say for the case where the same electrical bus connection is used for the supply of signals to the star circuit and for the supply of signals from the star circuit to a connected station, and also for the case where the electrical bus connection is formed by a twisted wire pair 14 which is terminated, at the input of the connection network, by a characteristic impedance 15. The connection network comprises a buffer element 16 and a logic circuit 17. A signal applied via the twisted wired pair 14 is stored in the buffer element 16 after having been converted into a single-wire signal by means of a detection circuit 18. As will be described hereinafter, this storage will be dependent on the initial value of the logic circuit 17; storage takes place at instants determined by the clock pulses CL. A buffer output signal derived from this stored signal is applied to the logic circuits of all connection networks belonging to the star circuit. The output signal of the logic circuit 17 is converted, using a drive circuit 19, into

voltage values which are suitable for the twisted wire pair 14. The coupling of the output of the logic circuit 17 to the twisted wire pair 14 is realized by means of a wired-AND logic function. In this respect it holds that, if the voltage value on an electrical bus connection is "1", no signal is present on this bus connection, while a signal to be applied via such a connection is characterized by the voltage value "0". Wired logic functions are known per se so that they need not be elaborated herein. If the bus connection is realized as a bidirectional single wire, the elements 18, 19 can be dispensed w:th. The input of the buffer element 16 and the output of the logic circuit 17 are then both connected to the relevant bus connection.

The star point circuit and the associated connection networks, one of which is shown in Figure 2, should satisfy the following requirements:

- When no signal is applied to any of the connection networks, none of these connection networks may apply a signal to the connected stations.
- When a signal is applied to any one of the connection networks, the relevant connection network may not output a corresponding signal; the other connection networks, however, should apply a corresponding signal to the stations connected thereto.
- In the connection network whereto a signal is applied it should be memorized that a signal originates from the station connected thereto and that this signal must be applied to theother stations.

A practical embodiment of a star circuit which comprises three connection networks and which satisfies these requirements is shown in Figure 3. In this respect it is assumed that the electrical bus connections are formed by a single wire, for example a coaxial lead. The buffer elements are composed of a D-flipflop 20, 21 and 22, respectively, and an AND-gate 23, 24, 25, respectively. The logic circuits are composed of an AND-gate 26, 27, 28, respectively, and an OR-gate 29, 30, 31 respectively. The outputs of the OR-gates are combined in a wired-AND configuration which is coupled to the bus connections at the input of the relevant D-flipflops; these wired-AND couplings are diagrammatically denoted by 32, 33 and 34, respectively. The signals applied to the connection networks are denoted by bi1, bi2 and bi3, respectively; the signals output by the logic circuits are denoted by b01, b02 and b03, respectively, the clock pulses for the flipflops being denoted by CL1, CL2 and CL3. The terminating impedances of the bus connections at the side of the star circuit are denoted by 35, 36 and 37, respectively.

The operation of the circuit shown in Figure 3 will be described with reference to the time diagrams shown in the Figures 4A and 4B. In the initial situation, $bi1 = bi2 = bi3 = 1$, $b01 = b02 = b03 = 1$, $S1 = S2 = S3 = 1$, so that $CL1 = CL2 = CL3 = C$. When a signal $bi1 = 0$ is applied to the upper connection network while bi2,3 remain 1, the signal bi1 is written into the flipflop 20 in response to the positive-going edge of the next clock pulse, so that S1 becomes 0 while S2,3 remain 1. This situation is shown in the time diagrams of Figure 4A. The AND-gates 27 and 28 are then blocked while the AND-gate 26 remains conductive, so that b02,3 become 0 and b01 remains 1. The signal (bi1) formed by the first station is thus applied to all other stations as b02, b03 by way of the wired AND-functions formed by the elements 32, 33, 34. This state changes only if the applied signal is interrupted again, so if bi1 becomes 1. This is because in response to the positive-going edge of the next clock pulse S1 become 1, the AND-gates 27 and 28 become conductive again and hence b02,3 become 1. Thus, the signal applied to the upper connection network is transferred to the bus connections connected to the other two connection networks and the initial situation has been restored. It is to be noted that during the period during which $b02,3 = 0$ the writing of the signal present on the bus connections into the flipflops 21 and 22 must be prevented; therefore, CL2, CL3 remain 0 during this period, which means that the write clock pulses for these flipflops are blocked.

Figure 4B shows the same series of time diagrams as shown in Figure 4A, be it for the situation where two stations substantially simultaneously output a signal intended for the other stations. This station, whereto the upper connection network is connected, outputs a signal $bi1 = 0$ which is intended for the stations whereto the other two connection networks are connected. The station whereto the second connection network is connected outputs a signal $bi2 = 0$ which is intended for the stations whereto the upper and the lower connection network are connected. These signals are written into the flipflops 20 and 21, respectively, in response to the positive going edge of the next clock pulse, with the result that S1,2 become 0 while S3 remains 1. As a result, b01,2 remain 1 and b03 becomes 0. When the applied signals disappear again, which means when bi1,2 become 1, the signal b03 also disappears, which means that b03 becomes 1 and the initial situation has been restored. Therefore, a signal is applied only to the station which is connected to the lower connection network. It again holds good that the clock pulses for the flipflop 22 are blocked for the period of time during which $b03 = 0$.

Claims

1. A communication device, comprising a star circuit (7) whereto a variable number of electrical bus connections with stations (1, 2, 3) coupled thereto can be connected in order to form, by way of the assembly of bus connections, a bus organization for digital communication signals between the assembly of stations, characterized in that for each electrical bus connection to be connected the star circuit comprises an own connection network (11, 12, 13) with a buffer element (20, 21, 22) and a logic circuit (26/29, 27/30, 28/31), a communication signal which originates from a first station and which is supplied via a relevant bus connection, being stored in the associated buffer element, a buffer output signal derived from said communication signal being applied to the logic circuit of all connection networks of the star circuit, the output signal of each of these logic circuits, with the exception of that of the connection network having received the communication signal originating from the first station, being applied, via a relevant bus connection, to a station connected thereto, each buffer element comprising a gate circuit (23, 24, 25) whereto the signal output via the output of the relevant logic circuit is applied in order to ensure that this signal, to be applied to a relevant station, is not written into the buffer element, each of the electrical bus connections between a relevant station and the star circuit being electrically terminated at both ends.

2. A communication device as claimed in claim 1, characterized in that the electrical bus connection via which a communication signal is applied from a station to the star circuit and that via which a communication signal is applied from the star circuit to the relevant station is the same, the output of each logic circuit being coupled to said electrical bus connection in a wired-logic configuration at the input of the relevant connection network, so that the bus connection carries a communication signal only if either a relevant station outputs a communication signal while no signal is output via the output of the relevant logic circuit, or if a signal is output via the output of the relevant logic circuit while no communication signal is output by the relevant station.

3. A star circuit (7) for use in a communication device as claimed in claim 1 or 2, comprising a series of connections for bus connections, each connection serving for a relevant station, for each connection there being provided an own connection network comprising:
   - a terminating impedance (35, 36, 37) for terminating the bus connection with its characteristic impedance;
   - a buffer element (20, 21, 22) which is connected to the connection in order to store a bus connection signal having an active value and a non-active value, respectively;
   - a multiple connection network (S_1, S_2, S_3) for communicating the storage state of each buffer element to all connection networks;
   - a combinatory logic network (26/29, 27/30, 28/31) which is fed by the respective connection networks in order to form an activation signal under the control of any stored active value with respect to another bus connection, unless an active value was stored in respect of the own bus connection, in which case an ignore signal is formed;
   - a return connection to a logic function which is included in the own bus connection in order to apply said activation signal as an active value to the own bus connection, the ignore signal not affecting the value of the own bus connection signal;
   - an inhibit connection for inhibiting, under the control of the activation signal, the storage of an active value in the buffer element.

4. A device comprising a built-in star circuit (7) as claimed in claim 3 and at least one station (1, 2, 3) which is internally connected thereto via an associated bus connection.

5. A device as claimed in claim 4, characterized in that said star circuit comprises at least one externally accessible connection for connection of an associated external station via an external bus connection.

Patentansprüche

1. Kommunikationsanordnung mit einer Sternschaltung (7), mit der eine änderbare Anzahl elektrischer Busverbindungen mit damit gekoppelten Stationen (1, 2, 3) verbindbar ist, um zum Aufbauen von Busverbindungen eine Busorganisation für digitale Kommunikationssignale zwischen dem Aufbau vom Stationen zu bilden, dadurch gekennzeichnet daß für jede an die Sternschaltung anzuschließende elektrische Busverbindung ein eigenes Verbindungsnetz (11, 12, 13) mit einem Pufferelement (20, 21, 22) und einer Logikschaltung (26/29, 27/30,

28/31) enthält, wobei ein aus einer ersten Station stammendes und über eine betreffende Busverbindung geliefertes Kommunikationssignal im zugeordneten Pufferelement gespeichert wird, ein aus dem Kommunikationssignal abgeleitetes Pufferausgangssignal an die Logikschaltung aller Verbindungsnetze der Sternschaltung gelegt wird, das Ausgangssignal jeder dieser Logikschaltungen mit Ausnahme derer des Verbindungsnetzes, das das Kommunikationssignal aus der ersten Station empfangen hat, über eine betreffende Busverbindung an eine damit verbundene Station gelegt wird, jedes Pufferelement eine Steuerschaltung (23, 24, 25) enthält, an die das Ausgangssignal über den Ausgang der betreffenden Logikschaltung zum Gewährleisten gelegt wird, daß dieses an eine betreffende Station zu legende Signal nicht in das Pufferelement eingeschrieben wird, und jede der elektrischen Busverbindungen zwischen einer betreffenden Station und der Sternschaltung an beiden Enden elektrisch abgeschlossen wird.

2. Kommunikationsanordnung nach Anspruch 1, dadurch gekennzeichnet, daß die elektrische Busverbindung, über die ein Kommunikationssignal von einer Station an die Sternschaltung gelegt wird, und die Busverbindung, über die ein Kommunikationssignal von der Sternschaltung nach der betreffenden Station geführt wird, dieselben sind, wobei der Ausgang jeder Logikschaltung an die elektrische Busverbindung in einer Phantom-Logikverknüpfung am Eingang des betreffenden Verbindungsnetzwerks gekoppelt wird, so daß die Busverbindung ein Kommunikationssignal nur dann führt, wenn entweder eine betreffende Station ein Kommunikationssignal ausgibt, während über den Ausgang der betreffenden Logikschaltung kein Signal ausgeht, oder wenn ein Signal über den Ausgang der betreffenden Logikschaltung ausgeht, während von der betreffenden Station kein Kommunikationssignal ausgeht.

3. Sternschaltung (7) zur Verwendung in einer Kommunikationsanordnung nach Anspruch 1 oder 2, mit einer Reihe von Verbindungen für Busverbindungen, wobei jede Verbindung für eine betreffende Station dient, wobei für jede Verbindung ein eigenes Verbindungsnetz vorgesehen ist, daß folgende Elemente enthält:
   - eine Abschlußimpedanz (35, 36, 37) zum Abschliessen der Busverbindung mit ihrer charakteristischen Impedanz;
   - ein Pufferelement (20, 21, 22), das mit der Verbindung verbunden ist, um ein Busverbindungssignal mit einem aktiven bzw. einem nicht aktiven Wert zu speichern;
   - ein mehrfaches Verbindungsnetz (S_1, S_2, S_3) zum Kommunizieren des Speicherzustands jedes Pufferelements an alle Verbindungsnetze;
   - ein Kombination-Logiknetz (26/29, 27/30, 28/31), das durch die betreffenden Verbindungsnetze zur Bildung eines Aktivierungssignals unter der Steuerung eines gespeicherten aktiven Werts in bezug aufeine andere Busverbindung gespeist wird, wenn nicht ein aktiver Wert in bezug auf die eigene Busverbindung gespeichert war, in welchem Fall ein Ignorierschaltung gebildet wird;
   - eine Rückkehrverbindung nach einer logischen Funktion, die in der eigenen Busverbindung enthalten ist, um das Aktivierungssignal als aktiver Wert an die eigene Busverbindung zu legen, wobei das Ignoriersignal den Wert des eigenen Busverbindungssignals nicht beeinflußt;
   - eine Blockierverbindung zum Blockieren der Speicherung eines aktiven Werts im Pufferelement unter der Steuerung des Aktivierungssignals.

4. Anordnung mit einer eingebauten Sternschaltung (7) nach Anspruch 3 und mit wenigstens einer Station (1, 2, 3), die damit inwendig über eine zugeordnete Busverbindung verbunden ist.

5. Anordnung nach Anspruch 4, dadurch gekennzeichnet, daß die Sternschaltung wenigstens eine extern zugängliche Verbindung zum Verbinden einer zugeordneten externen Station über eine externe Busverbindung enthält.

Revendications

1. Dispositif de communication comprenant un circuit en étoile (7) auquel un nombre variable de connexions de bus électriques avec des postes (1, 2, 3) qui y sont couplés peut être connecté afin de former, par l'intermédiaire de l'ensemble des connexions de bus, une organisation de bus pour des signaux de communication numériques entre l'ensemble de postes, caractérisé en ce que, pour chaque connexion de bus électrique à connecter, le circuit en étoile comprend un réseau de connexion propre (11, 12, 13) avec un élément tampon (20, 21, 22) et un circuit logique (26/29, 27/30, 28/31), un signal de communication, qui provient d'un premier poste et qui est fourni par l'intermédiaire d'une connexion de bus corres-

pondante, étant stocké dans l'élément tampon associé, un signal de sortie de tampon dérivé du signal de communication étant appliqué au circuit logique de tous les réseaux de connexion du circuit en étoile, le signal de sortie de chacun de ces circuits logiques, à l'exception de celui du réseau de connexion qui a reçu le signal de communication provenant du premier poste, étant appliqué, par l'intermédiaire d'une connexion de bus correspondante, à un poste qui y est connecté, chaque élément tampon comprenant un circuit-porte (23, 24, 25) auquel la sortie de signal par l'intermédiaire de la sortie du circuit logique en question est appliquée afin d'assurer que ce signal, à appliquer à un poste en question, ne soit pas enregistré dans l'élément tampon, chacune des connexions de bus électriques entre un poste en question et le circuit en étoile étant terminée électriquement aux deux extrémités.

2. Dispositif de communication suivant la revendication 1, caractérisé en ce que la connexion de bus électrique par l'intermédiaire de laquelle un signal de communication est appliqué d'un poste au circuit en étoile et celle par l'intermédiaire de laquelle un signal de communication est appliqué du circuit en étoile au poste en question sont les mêmes, la sortie de chaque circuit logique étant couplée à la connexion de bus électrique selon une configuration logique câblée à l'entrée du réseau de connexion en question, de sorte que la connexion de bus ne porte un signal de communication que si un poste en question sort un signal de communication tandis qu'aucun signal n'est sorti par la sortie du circuit logique en question, ou si un signal est sorti par la sortie du circuit logique en question alors qu'aucun signal de communication n'est sorti par le poste en question.

3. Circuit en étoile (7) à utiliser dans un dispositif de communication suivant la revendication 1 ou 2, comprenant une série de connexions pour des connexions de bus, chaque connexion desservant un poste correspondant, un réseau de connexion propre étant prévu pour chaque connexion, comprenant :
   - une impédance de terminaison (35, 36, 37) pour terminer la connexion de bus par son impédance caractéristique;
   - un élément tampon (20, 21, 22) qui est connecté à la connexion afin de stocker un signal de connexion de bus ayant une valeur active et une valeur non active, respectivement;
   - un réseau de connexion multiple (S_1, S_2, S_3) pour communiquer l'état de stockage de chaque élément tampon à tous les réseaux de connexion;
   - un réseau logique combinatoire (26/29, 27/30, 28/31) qui est alimenté par les réseaux de connexion respectifs afin de former un signal d'activation sous la commande d'une quelconque valeur active stockée pour une autre connexion de bus, à moins qu'une valeur active n'ait été stockée pour sa connexion de bus propre, auquel cas un signal d'omission est formé;
   - une connexion de retour à une fonction logique qui est incluse dans la connexion de bus propre afin d'appliquer le signal d'activation en tant que valeur active à la connexion de bus propre, le signal d'omission n'affectant pas la valeur du signal de connexion de bus propre;
   - une connexion d'interdiction pour interdire, sous la commande du signal d'activation, le stockage d'une valeur active dans l'élément tampon.

4. Dispositif comprenant un circuit en étoile incorporé (7) suivant la revendication 3 et au moins un poste (1, 2, 3) qui y est connecté intérieurement par l'intermédiaire d'une connexion de bus associée.

5. Dispositif suivant la revendication 4, caractérisé en ce que le circuit en étoile comprend au moins une connexion accessible de l'extérieur pour la connexion d'un poste externe associé par l'intermédiaire d'une connexion de bus externe.

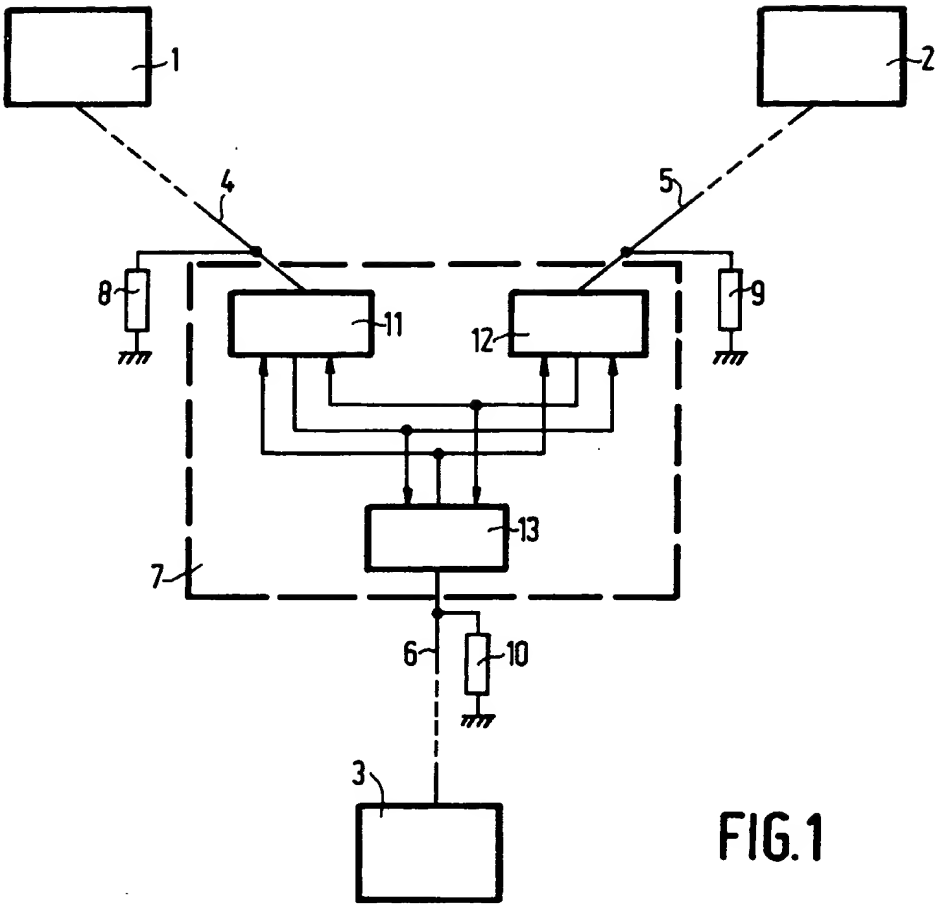

FIG.1

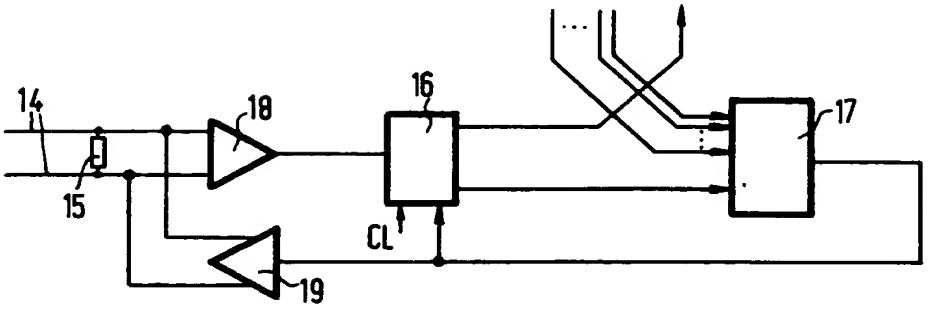

FIG. 2

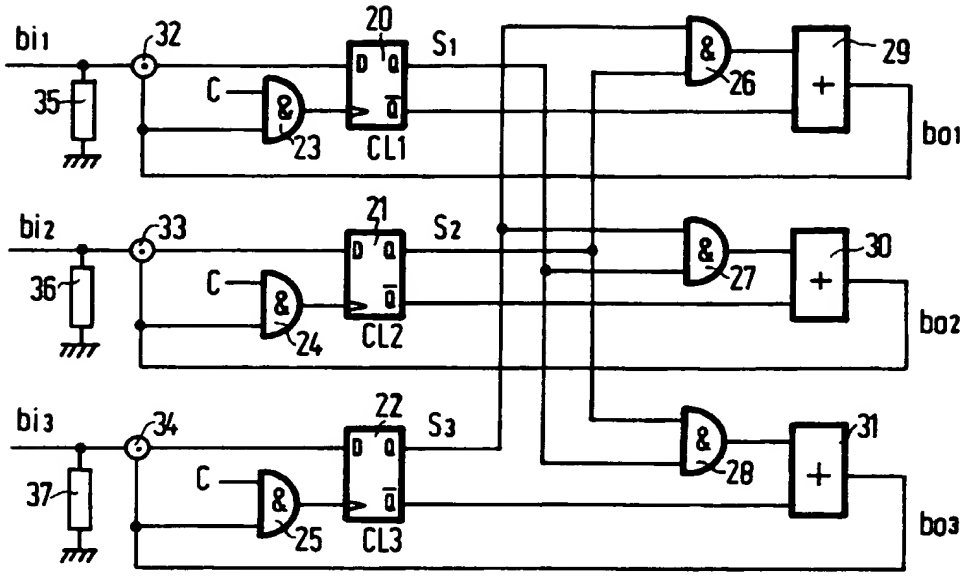

FIG. 3

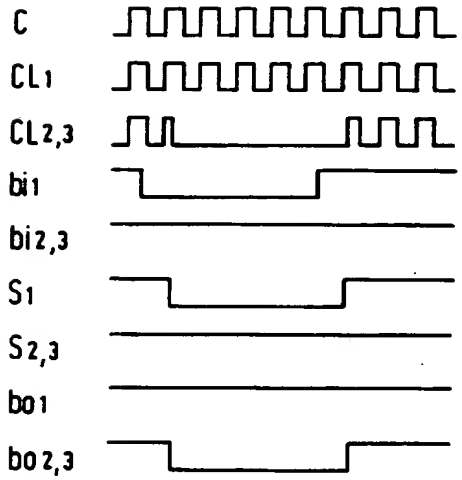

FIG. 4A

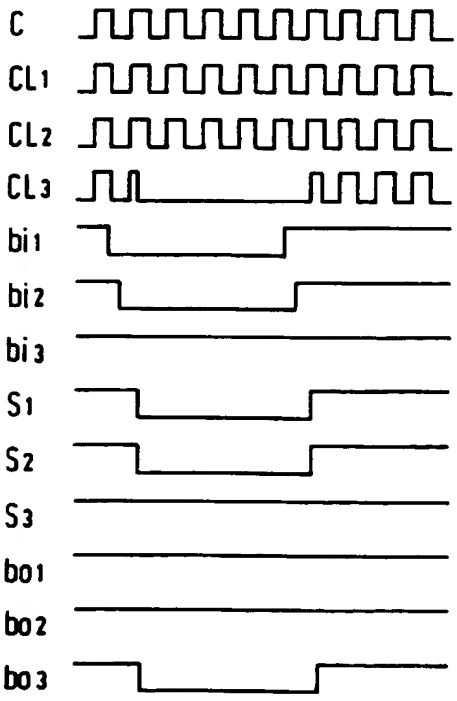

FIG. 4B